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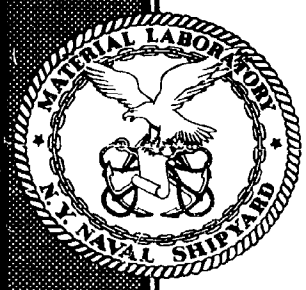

TECHNICAL REPORT

MATERIAL LABORATORY

NEW YORK NAVAL SHIPYARD
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RESEARCH REPORT
on

THE THERMAL INJURY UNDERNEATH CLOTHING
Progress, April-June 1956

Lab. Project 5046-16, Progress Report 1
NS 081-001
AFSWP-1008
Technical Objectives AW-7, SR-2a

10 September 1956

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Lab. Project 5046-16
Progress Report 1

ADMINISTRATIVE INFORMATION

1. The Naval Material Laboratory's study of the Thermal Injury Underneath Clothing was originally proposed in the Laboratory's letter, Serial 961-081, of 18 July 1955 and was formally approved in Armed Forces Special Weapons Project's letter SWPEF-5/928 of 20 January 1956.

ACKNOWLEDGMENTS

2. The work reported herein represents the combined efforts of personnel of the Optics Section under the supervision of T. I. Monahan, Section Head, and, in particular, of the personnel of the Thermal Radiation Physics Unit and the Thermal Radiation Materials Unit under the supervision of W. L. Derksen and R. C. Maggio, respectively. T. D. Murtha, J. A. Carter, A. Hirschman and G. deLhery contributed significantly to the investigation. E. Garde and J. Filosa were responsible for the care of and anaesthetizing of the rats and in the depilation of rat skin. Acknowledgment is made of the invaluable assistance of Dr. George Mixter, Jr., M.D., consultant to this project, in evaluating the burns to the rat and in establishing a uniform system of grading burns.

REPORT OF PROGRESS

3. The general purpose of the project is to study, from a physical viewpoint, the amount of protection afforded human skin by clothing systems exposed to the intense thermal radiation of nuclear detonations. The immediate objective of the project is to evaluate the burn protection of current and proposed service uniform systems as a function of intensity and time of exposure, using a laboratory pulse simulating the temporal variation of radiant flux during a nuclear explosion. The data obtained under representative situations will permit field commanders to estimate the number of burn casualties in a given military situation. A secondary objective of this study is to obtain experimental data in support of and for the purpose of validating the plastic skin simulant under development by the Naval Material Laboratory.

4. The Laboratory experiments employ a carbon-arc source of radiation whose intensity varies with time in a manner similar to the field pulse. Rat skin is employed as the biological matter for these experiments.

5. During the period covered by this report, the following subtasks were prosecuted:

a. Study of the protection afforded by the standard Army, Navy, and Air Force service uniforms is being made under fixed exposure and environmental conditions which represent average field conditions as much as possible. The yields of the simulated weapons cover the range of operational weapons in the conventional atomic and thermonuclear classes. A general relationship will be drawn, correlating weapon yield and the radiant exposure required to cause an incapacitating burn. The uncovered animal burn is studied only for the purpose of correlating the results of these experiments with those of other investigations.

b. This subtask has for its objective the proof-testing of the plastic skin simulant by comparing the temperature histories of simulant, animal and human under representative radiant-energy-burn conditions. With the acquisition of these data it will be possible to establish a useful skin-simulant-temperature criterion for determining the equivalent burn severity in the animal and human.

The progress on these subtasks is reported herein.

6. During the current period facilities for handling and housing the experimental animals were established and personnel were instructed and trained in the various duties required in the use of rats for burn studies. A contract was negotiated with the Charles River Breeding Laboratories, Brookline, Massachusetts, for the regular periodic delivery of 50-day-old Sprague-Dawley female rats weighing 150 grams. Procedures and techniques for anaesthetizing, and depilating the rats were established.

7. Exposures of the rat to carbon-arc radiation, when in contact with the standard Hot-Wet uniform assembly were made for pulses of 0.5 and 3.3 seconds (these times correspond to the interval in which the irradiance of the generalized pulse rises to its maximum value). The uniform was a 5 oz/yd^2 poplin over a 4 oz/yd^2 sheeting; both fabrics had been laundered once, then ovendried and stored at 65 percent relative humidity. A cavity was placed in front of the cloth during the exposure to simulate negligible air supply. The burns were assessed immediately after exposure (2-10 minutes). The rats were also examined after 24 hours to note formation of scab.

8. Analysis of the burn data indicate that the radiant exposure to cause a just perceptible or minimal white burn to rat skin is 5.7 cal/cm^2 for the 0.5-second laboratory simulated-field pulse and 8.6 cal/cm^2 for the 3.3-second pulse; which values correspond to equivalent field radiant exposures of 7.3 cal/cm^2 and 11 cal/cm^2, respectively. The 95 percent confidence level was computed to be in the order of 5 percent of the quoted value.

9. Temperatures of the surface of the rat skin were determined immediately prior to and during the exposures. Initial temperatures averaged 31°C. The maximum temperature rise corresponding to a minimal white burn was 33°C for the 0.5-second pulse, resulting in a rise to 64°C at 3 seconds. The maximum temperature rise corresponding to the minimal white burn for the 3.3-second pulse was 30°C, resulting in a rise to 61°C at 8.3 seconds.

10. The unclothed or bare skin of the rats has been evaluated. The critical radiant exposure for the minimal white burn for the 0.5-second laboratory simulated-field pulse was 5.6 cal/cm^2 and for the 3.3-second pulse 7.4 cal/cm^2, which correspond to radiant exposures for the equivalent field pulse of 7.2 cal/cm^2 and 9.5 cal/cm^2, respectively. The maximum temperatures of the skin are 91°C and 58°C for the 0.5-second and 3.3-second pulses, respectively.

11. The spectral reflectance of the skin of the depilated rat was measured and found to correspond very closely to that of average human skin for red and infrared radiation out to 2.7 microns. The reflectance for radiation in the blue and green part of the spectrum was measurably greater than that of human skin.

12. As significant data become available, formal reports will be issued on the various phases of this project.

APPROVED:

W. E. JEREMIAH, COMMANDER, USN
For the Director

sp

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